Name _____ Date _____ Class _____ AF

Properties of Acids and Bases

Lab Discussion

Acids ionize in aqueous solution to produce hydronium ions (H_3O^+). The strength of an acid depends on the degree to which it ionizes. Strong acids ionize almost completely, while weak acids ionize to a lesser degree. Bases dissociate in aqueous solution to produce hydroxide ions (OH^-). (Ammonia gas, NH_3, actually ionizes in aqueous solution to produce a weak base.) The properties of acids and bases depend on the presence of free H_3O^+ or OH^- as the predominant ion in a solution.

In this experiment, you will observe the following:

1. The effects of acids and a base on various indicators.
2. Reactions of acids and metals. The single replacement can be represented by the general equation:

$$\text{metal} + \text{acid} \rightarrow \text{metallic ion} + \text{hydrogen gas} + \text{water}$$

$$M(s) + 2H_3O^+(aq) \rightarrow M^{2+}(aq) + H_2(g) + 2H_2O(l)$$

3. Reaction of an acid with a carbonate. The double replacement reaction can be represented by the general equation:

$$\text{carbonate} + \text{acid} \rightarrow \text{carbon dioxide} + \text{water}$$

$$CO_3^{2-}(aq) + 2H_3O^+(aq) \rightarrow CO_2(g) + 3H_2O(l)$$

4. Neutralization reaction. Acids neutralize bases (and vice versa). For example, when HCl combines with NaOH, the net reaction is $H_3O^+ + OH^- \rightarrow 2H_2O$. In this reaction, 1 mole of HCl neutralizes 1 mole of NaOH.
5. The effects of some common household substances on various indicators.

This experiment should aid in the understanding of the properties and reactions of acids and bases, neutralization reactions, single and double replacement reactions, and the relative activities of metals.

Purpose

Observe and study some typical properties and reactions of acids and bases.

Equipment

test tubes, 18×150-mm (5)
test tube rack
dropper pipets (2)
microspatula (or scoop)
spot plate
wood splint
rubber stopper, 1-hole (to fit test tube)
glass tubing, with right-angle bend
safety goggles
lab apron or coat

Materials

6 *M* HCl
6 *M* $HC_2H_3O_2$
0.5 *M* NaOH
1.0 *M* HCl
phenolphthalein solution
litmus paper, red and blue
pH paper
limewater
zinc, mossy
magnesium ribbon
iron filings
copper wire (or sheet)
$CaCO_3$
vinegar
lemon juice
tomato juice
milk
household ammonia

Safety

Handle acid and base solutions with care, and avoid spills on your clothing or skin. Flush any spills with cool water and $NaHCO_3$ solution and report them to your teacher. Note the caution alert symbols here and with certain steps in the "Procedure." Refer to page xi to review the precautions associated with each symbol. Always wear safety goggles and a lab apron or coat when working in the lab.

Procedure

Note: All observations should be recorded in the appropriate spaces in the "Observations and Data" section.

PART A EFFECT OF ACIDS AND BASE ON INDICATORS

1. To separate depressions in your spot plate, add about five drops of each of the following: (1) 6 *M* HCl; (2) 6 *M* $HC_2H_3O_2$; (3) 0.5 *M* NaOH. **CAUTION:** *Handle these chemicals with care.* Using a different piece of clean, dry red litmus paper for each of the three solutions, dip the end of a piece of red litmus paper into each solution.
2. Next, dip the ends of pieces of blue litmus paper into the same depressions. Finally dip the ends of pieces of pH paper into the same depressions.
3. Add one drop of phenolphthalein to the solution in each depression. Discard the solutions as instructed and rinse the spot plate with water. Then dry it with a paper towel.

PART B REACTIONS OF ACIDS WITH METALS

4. To separate depressions on one side of your spot plate, add small quantities of each of the following: (1) zinc (2) magnesium (3) iron (4) copper.
5. To each depression, add just enough 6 *M* HCl to cover the metal. Observe the relative reactivities of the metals with this acid.
6. On the other side of your spot plate, repeat steps 4 and 5 using 6 *M* $HC_2H_3O_2$ in place of the HCl. Contrast each metal's reactivity with $HC_2H_3O_2$ against each metal's reactivity with HCl. Discard the contents of the spot plate as instructed and rinse and dry the spot plate.
7. Place a small quantity of zinc in a depression in your spot plate. Add enough 6 *M* HCl to just cover the zinc. As the reaction proceeds, hold an inverted test tube over the zinc for about 1 minute. Without turning the test tube upright, quickly insert a *burning* wood splint into the test tube. Discard the contents of the spot plate and clean and dry the plate.

PART C REACTIONS OF ACIDS WITH CARBONATES

8. *Carefully* insert a right-angle bend of glass tubing into a one-hole rubber stopper.
9. Half fill a clean test tube with limewater solution. Place a small amount of $CaCO_3$ into a second clean test tube. Add enough 6 *M* HCl to just cover the carbonate. Insert the rubber-stopper-glass-tubing assembly into the test tube containing the $CaCO_3$ and HCl.
10. Put the open end of the glass tubing into the limewater solution in the test tube.
11. Discard the solutions and clean and rinse the test tubes.

PART D NEUTRALIZATION

12. Using a clean dropper pipet, add 10 drops of 1.0 *M* HCl to a clean test tube. Add one drop of phenolphthalein. Test with pH paper.
13. Using a second dropper pipet, add 0.5 *M* NaOH drop by drop to the acid in the test tube. After the addition of each drop, swirl the test tube gently so the drop mixes thoroughly with the acid. Count the total number of drops of NaOH needed to cause a color change. Once a color change is observed, test the mixture with pH paper.

PART E ACIDITY AND BASICITY OF HOUSEHOLD SUBSTANCES

14. To different depressions in your spot plate, add about five drops of each of the following: vinegar, lemon juice, tomato juice, milk, household ammonia.
15. Test each substance as you did in Part A, using red litmus paper, blue litmus paper, pH paper, and phenophthalein.

Observations and Data

AF

PART A

DATA TABLE

	red litmus	blue litmus	pH paper	phenolphthalein
6 *M* HCl				
6 *M* $HC_2H_3O_2$				
0.5 *M* NaOH				

PART B

1. Reactivity in decreasing order (fastest to slowest):

1. _____ 2. _____ 3. _____ 4. _____

2. Comparative reactivities (very fast, fast, slow, very slow, no apparent reaction):

	with HCl	with $HC_2H_3O_2$
zinc		
magnesium		
iron		
copper		

3. Results of burning splint test:

PART C

4. Results of limewater test:

PART D

5. Number of drops of 0.5 *M* NaOH to neutralize 10 drops of 1.0 *M* HCl:

_____

pH of neutral solution: _____

PART E

DATA TABLE

	red litmus	blue litmus	pH paper	phenolphthalein
vinegar				
lemon juice				
tomato juice				
milk				
household ammonia				

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Equations

Write balanced molecular equations for the reaction of:

1. each metal with 6 *M* HCl

2. each metal with 6 *M* $HC_2H_3O_2$

3. $CaCO_3$ with HCl

4. HCl with NaOH

Conclusions and Questions

1. What type of reaction occurs between a metal and an acid? Write a general equation for this type of reaction.

2. Explain the difference in reaction rates of a given metal with two different acids.

3. Write a balanced equation for the reaction between CO_2 gas and lime-water, $Ca(OH)_2$. What is the name of the milky precipitate that forms?

4. Explain the difference in the volumes (number of drops) of HCl and NaOH required to produce a neutral solution in Part D of this experiment.

5. Which household substances were acidic? Which was almost neutral? Which was basic?